

CLAIMS:

1. An optical system for presenting virtual optical images of an image source outputting light in a forward direction at a desired apparent distance comprising:
 - 5 (a) a first at least partially light transmissive member having a non-uniform transmission characteristic for receiving light from said image source and outputting altered light in a forward direction;
 - (b) a partially transparent and partially reflective focusing member receiving said altered light and outputting transmitted altered light; and
 - (c) a partially transmissive and partially reflective member for reflecting said transmitted altered light in a
- 10 rearward direction toward said focusing member, said focusing member having the characteristic of reflecting said reflected transmitted altered light, and said partially transmissive and partially reflective member transmitting reflected transmitted altered light reflected from said partially transparent and partially reflective focusing member.
- 15 2. An optical system as in claim 1, wherein said first at least partially light transmissive member having a non-uniform transmission characteristic for receiving light from said image source and outputting altered light comprises a first polarizer.
- 20 3. An optical system as in claim 2, wherein said first polarizer comprises a circular polarizer comprising a linear polarizer and quarter wave plate.
- 25 4. An optical system as in claim 3, wherein said partially transparent and partially reflective focusing member receiving said altered light and outputting transmitted altered light comprises a partially transmissive concave mirror.
5. An optical system as in claim 4, wherein said partially transmissive and partially reflective member for reflecting said transmitted altered light in a rearward direction toward said focusing member comprises a quarter wave plate and a reflective/transmissive polarizer.
- 30 6. An optical system as in claim 1, wherein said partially transmissive and partially reflective member for reflecting said transmitted altered light in a rearward direction toward said focusing member comprises a quarter wave plate and a reflective/transmissive polarizer.
- 35 7. An optical system for presenting virtual optical images of an image source outputting light in a forward direction at a desired apparent distance comprising:

(a) a first linear polarizing element oriented to receive light from said image source and output first linearly polarized light having an orientation in a first direction, said first linear polarizing element being oriented in said first direction;

(b) a first elliptical polarizing member oriented in a second direction and positioned to receive said first linearly polarized light and output first elliptically polarized light, said first elliptically polarized light being oriented in a first elliptical direction;

(c) a partially transparent and partially reflective focusing member positioned to receive said first elliptically polarized light and transmit a portion of said first elliptically polarized light;

(d) a second elliptical polarizing member positioned to receive said portion of said first elliptically polarized light from said focusing member and transmit said portion of said first elliptically polarized light as second linearly polarized light, said second linearly polarized light being oriented in said first direction; and

(e) a reflective-transmissive polarizer configured and positioned to reflect light having a linear polarization in said first direction and transmit light having a linear polarization in a direction transverse to said first direction, said second elliptical polarizing member being configured and positioned to convert linearly polarized light reflected in a rearward direction by said reflective-transmissive polarizer into second elliptically polarized light with said second elliptically polarized light being polarized in said first elliptical direction, said concave mirror being positioned to reflect in a forward direction said second elliptically polarized light as third elliptically polarized light, said third elliptically polarized light having a second elliptical direction different from said first elliptical direction, and said second elliptical polarizing member being positioned to convert said third elliptically polarized light into third linearly polarized light, transmitting said third linearly polarized light in a forward direction, said third linearly polarized light being oriented in a second direction transverse to said first direction, whereby said reflective-transmissive polarizer transmits said third linearly polarized light in a forward direction.

8. An optical system as in claim 7, further comprising:

(f) a second linear polarizing element oriented to receive light from said reflective-transmissive polarizer, said second linear polarizing element being configured and positioned to transmit light having a linear polarization in said second direction.

9. An optical system as in claim 7, wherein said elliptical polarizing members are circular polarizing members.

10. An optical system as in claim 9, wherein said circular polarizing members are quarter wave plates.

11. An optical system as in claim 7, wherein said elliptical polarizing members are manufactured using a coating process.

12. An optical system as in claim 7, wherein said reflective-transmissive polarizer is formed of a liquid crystal material.

13. An optical system as in claim 7, wherein said elliptical polarizing members are coated onto opposite sides of said partially transparent and partially reflective concave mirror.

14. An optical system as in claim 7, wherein said elliptical polarizing members are circular polarizing members and said circular polarizing members are quarter wave plates.

15. An optical system as in claim 7, wherein said reflective-transmissive polarizer comprises a wire grid.

16. An optical system as in claim 7, wherein said first and second elliptical polarizing members are one quarter wave retarders comprising liquid crystal materials configured to incorporate characteristics tailored to correct darkened corner phenomenon.

17. An optical system as in claim 7, wherein said first and second elliptical polarizing members are configured to incorporate characteristics tailored to correct darkened corner phenomenon.

18. An optical system as in claim 7, further comprising an image source comprising a polarized projector and a screen fabricated with liquid crystal materials that largely maintain the linear polarization of said projector.

19. An optical system as in claim 7, wherein said reflective-transmissive polarizer comprises a liquid crystal member.

20. An optical collimating apparatus for focusing an image at or closer than at an infinite distance from an observer, comprising:

- (a) a first elliptical polarizing filter;
- (b) a semi-reflective concave mirror; and
- (c) a reflective-transmissive polarizing member.

21. An optical collimating apparatus as in Claim 20, further comprising:

- (d) a second elliptical polarizing filter.

22. An optical collimating apparatus as in Claim 21, wherein said first and second elliptical polarizing filters are positioned on opposite sides of said semi-reflective concave mirror.

23. An optical collimating apparatus as in Claim 22, wherein said reflective-transmissive polarizing member is panchromatic.

24. An optical collimating apparatus as in Claim 23, wherein said reflective-transmissive polarizing member receives linearly polarized light and outputs linearly polarized light.

25. An optical collimating apparatus as in Claim 20, wherein said reflective-transmissive polarizing member receives linearly polarized light and outputs linearly polarized light.

26. An optical collimating apparatus as in Claim 25, wherein said first and second elliptical polarizing filters are positioned on opposite sides of said semi-reflective concave mirror.

27. Image-forming apparatus comprising a first linear polarizer, a first quarter-wave plate adjacent said first polarizer and having its fast and slow axes at substantially 45° to the plane of polarization of said first polarizer, a beam-splitting curved mirror having a convex surface adjacent the first polarizer and facing towards the first quarter-wave plate, a second quarter-wave plate adjacent the concave side of the curved mirror, said second quarter-wave plate having its fast and slow axes oriented with respect to the corresponding axes of the first quarter-wave plate at angles substantially equal to a first integral multiple of 90° , and a reflective-transmissive polarizing member adjacent said second quarter-wave plate.

28. Image-forming apparatus as in Claim 27, further comprising a second linear polarizer adjacent said reflective-transmissive polarizing member, the second linear polarizer having its plane of polarization oriented with respect to the plane of polarization of the first linear polarizer at an angle substantially equal to a second integral multiple of 90° , both of said multiples being even or both being odd.

29. An optical collimating apparatus as in Claim 28, wherein said reflective-transmissive polarizing member receives linearly polarized light and outputs linearly polarized light.

30. Image-forming apparatus for forming an image appearing as if at a distance, comprising a first linear polarizer, a first quarter-wave plate, a beam-splitting curved mirror having a convex surface adjacent the first polarizer, a second quarter-wave plate adjacent the concave side of the curved mirror, said second

quarter-wave plate, and a pseudo-depolarizing member positioned to filter the output of the imaging forming apparatus.

- 5 31. Image-forming apparatus as in Claim 30, wherein said first quarter-wave plate has its fast and slow axes at substantially 45° to the plane of polarization of said first polarizer, said beam-splitting curved mirror faces towards the first quarter-wave plate, and said second quarter-wave plate has its fast and slow axes oriented with respect to the corresponding axes of the first quarter-wave plate at angles substantially equal to a first integral multiple of 90° .
- 10 32. Image-forming apparatus as in Claim 30, further comprising a reflective-transmissive polarizing member adjacent said second quarter-wave plate.
33. An optical system as recited in Claim 1 and comprising at least one aspheric focusing member.
- 15 34. An optical system as recited in Claim 1 and comprising at least two aspheric focusing members.
35. An optical system as recited in Claim 34, wherein the optical system is contained within a cellular telephone.